FPGA Lab 8 – RS232 Interface

Purpose: In this lab you will build a simple RS-232 serial interface that will connect to your computer. We will perform simple single-byte transfers in this lab. In the next lab we will use this interface to download moderate size files into the memory of the FPGA.

1) **Loop-back interface.** Let's first demonstrate a simple connection between the computer and the FPGA board. This first exercise will be good for demonstrating that the computer's interface is working properly. Opening the Lab8 file, you will find a simple design that loops-back the RS-232 output from the computer back into its input interface. Compile the design and load it into the LiveDesign board. Note that a dipswitch input turns on and off the loopback feature.
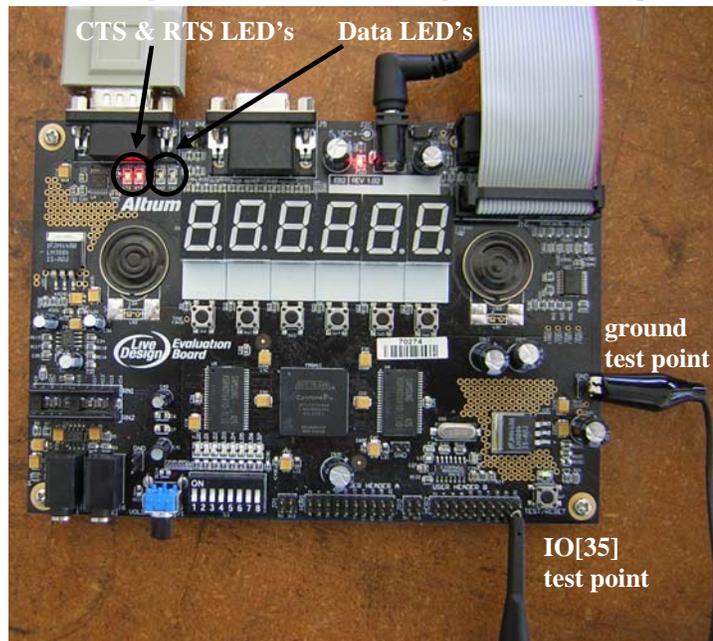
2) To test the interface, open up the "hyperterminal" interface that has a shortcut to your desktop. When you start the program, note that the "CTS" LED turns on, indicating that the computer is putting active its output on RS-232 interface. Note that the LiveDesign board grounds the "RTS" signal, also making active the output of the LiveDesign interface. With both lines active, the computer interface should now work.

3) First, set the baud rate of the interface (the bit rate of the data transfer). First, stop the interface by clicking on the "phone off the hook" icon. Note that the CTS LED will go off. Next, choose "File/Properties" and select the "configure" button. Initially, let's test at the slowest

transfer rate, 110 baud. Click the "phone on the hook" button to restart the interface. When you type a character, you will see the receive LED flash, as well as sound come from the speaker. If the loopback is turned on (via the dipswitch), you will also see the "TXD" LED flash, and the character appear on the hyperterminal. Note that the hyperterminal only displays received data, so a keystroke will be displayed on the computer only when the loopback is turned on.

4) Why does the tone from the speaker change with the different keys?

5) You may look at the serial data directly by connecting your oscilloscope to the IO[35] test pin on the LiveDesign board, as indicated in the above picture. To see the waveforms more easily, set the Baud rate to 1200. Look at the output waveform coming from various keystrokes. (Hold down the key to repeat the output). In particular, try to output the following byte values: "ctrl-a"="B00000001", "ctrl-b"="B00000010", "ctrl-

d"="B00000100", and U="B01010101". (For the correspondence between the keys and the byte values, see page 721 of HH). Make sure you understand the output level for the start bit, the order of transmission of bits, and the polarity of the output bits, as you will need this for making the interface. What is the width in time of each of the output bits? How does this relate to the baud rate 1200?
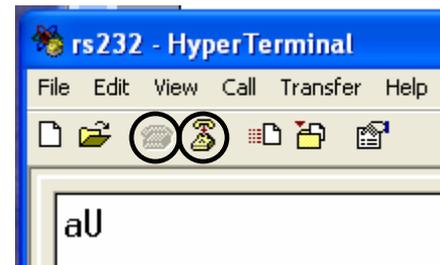
6) Set the baud rate on the hyperterminal to 115200, the maximum rate for the interface. Check for proper operation.

7) **RS-232 interface:** Using the design outlined in class, make an RS-232 receiver that displays the input byte as both LED outputs and two hexadecimal numbers. For simplicity, you should code the interface for operation only at 115200 baud.